

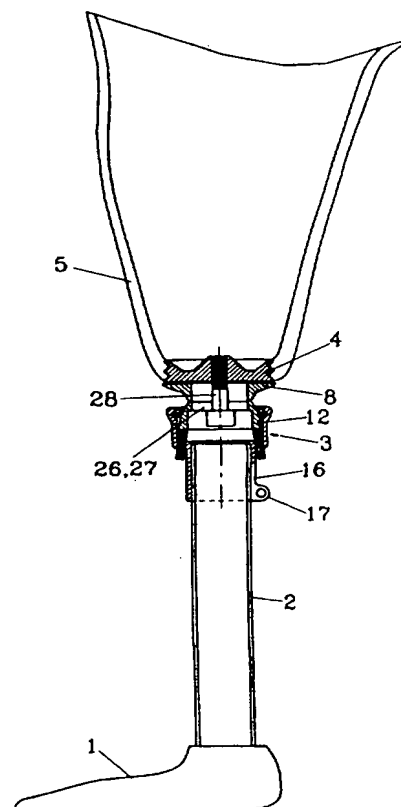
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>A61F 2/62</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 97/17042</b> <b>(43) International Publication Date:</b> 15 May 1997 (15.05.97)
<b>(21) International Application Number:</b> PCT/SE96/01422 <b>(22) International Filing Date:</b> 6 November 1996 (06.11.96) <b>(30) Priority Data:</b> 9503944-2 7 November 1995 (07.11.95) SE <b>(71) Applicant (for all designated States except US):</b> GRAMTEC INNOVATION AB [SE/SE]; Strömbacken 1, S-511 56 Kinna (SE). <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> GRAMNÄS, Finn [SE/SE]; Brantalid 18, S-511 56 Kinna (SE). <b>(74) Agent:</b> GÖTEBORGS PATENTBYRÅ AB; P.O. Box 5005, S-402 21 Göteborg (SE).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> With international search report. With amended claims. In English translation (filed in Swedish).

**(54) Title:** ADJUSTABLE ADAPTER FOR LOWER LEG PROSTHESIS**(57) Abstract**

An adjustable adapter (13) for lower leg prostheses including an adapter housing (14) attachable to the lower leg prosthesis (2), a spheroidal adapter head (8) rotatable inside the housing (14) and a prosthesis collar attachment member (4) that can be shifted sideways relative to the adapter head (8), which member (4) can be fastened to a prosthesis collar (5) whereby the spheroidal part (12) of the adapter head (8) is on the exterior of the essentially tube shaped adapter head (8) having an internally tube shaped part in which there are parts (26, 27, 28) arranged to allow the prosthesis collar attachment member (4) to be shifted sideways.



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## Adjustable adapter for lower leg prosthesis

The present invention pertains to an adjustable adapter for lower leg prostheses of the type described in the preamble to patent claim 1.

Prostheses for the knee, lower leg or foot are normally fastened to the bearer's bone using a prosthesis collar. To make the prosthesis adjustable at the desired angle and to make it possible to adjust it transversely to the prosthesis collar adapters for that purpose have previously been proposed.

SE-B-8602143-3 describes a lower leg prosthesis equipped with such an adapter which includes a prosthesis collar attachment member for attachment to the lower collar of the prosthesis. On the side facing the prosthesis collar the prosthesis collar attachment member is screwed to an adapter element including a little hemisphere around the screw shaft, which hemisphere is made rotatable against a corresponding spheroidal inner surface in an adapter housing which is attached to a lower leg prosthesis at its opposite end. At a distance from the hemisphere there is a concentrically attached disc against which the prosthesis collar attachment abuts. Further, there are external bosses on the adapter housing equipped with threaded penetrating holes at an angle to the central axis in which pinning screws can be screwed in from below so that their front ends press against the disc attached to the hemisphere thus pressing the adapter housing to different angular positions relative to the adapter housing. The prosthesis collar attachment element has a penetrating hole of significantly greater dimensions than the fastening screws in it whereby using a washer it is possible to attach the prosthesis collar attachment element in different sideways adjustable positions relative to the adapter housing. Using this design it is possible to achieve different angular positions without detaching the prosthesis, but because of the small radius of the sphere the angular variation is relatively limited. At the same time a sideways adjustment can be achieved but for this it is necessary that the whole prosthesis including the prosthesis collar be detached to reach the side adjustment screws, all of which makes fitting more difficult.

Other types of similar adapters have the two adjustment functions separated to such a degree that the designs are large and unwieldy.

The purpose of the present invention is to provide an adjustable adapter for a lower leg prosthesis for which the above disadvantages are essentially eliminated, which has been achieved by giving the adapter the characteristics described in the characterising parts of the patent claims.

In the following the invention will be described in greater detail with reference to the exemplifications illustrated schematically in the attached figures.

Fig. 1 shows an exemplification of a lower leg prosthesis with included adapter according to the present invention in schematic cross section from the side.

Fig. 2 is a side view of the adapter according to Fig. 1.

Fig. 3 shows a blow-up view from the side of the adapter according to Fig. 2.

Fig. 4 is a blow-up view corresponding to Fig. 3 which shows the adapter's most important parts in section.

Fig. 5 shows an adapter head included in the adapter according to the invention in a view from above.

Fig. 6a-g show different adjustments of the adapter according to the invention in side views seen in section.

In Fig. 1 a prosthesis foot 1 with an adjacent long leg like element, preferably a tube 2, appropriately made of aluminum or another light strong material, is shown schematically. On the end facing away from the prosthesis foot the leg like element 2 is attached to an adapter 3 according to the invention, which is affixed to a prosthesis collar 5 using a prosthesis collar attachment member 4 that can be adjusted relative to the attachment end of the leg like element.

Fig. 2 to 4 show the adapter according to Fig. 1 on a larger scale from the side in a blow up view and in a blow up view in section, respectively. It is clear from the figures that the previously mentioned prosthesis collar attachment member 4 is included in the adapter 3, which member in the shown design consists of a circular disc with external grooves 6 which facilitate attachment of the member 4 to the prosthesis collar. In the shown design the disc has a central threaded hole 7 (see Fig. 1 and Fig. 4). For reasons to be given shortly, the prosthesis collar attachment member 4 or the central hole 7 can include an oblong hole (not shown). Further included in the adapter 3 is an adapter head 8 consisting of a collar with a circular ring shaped end surface 9 facing toward the prosthesis collar attachment member 4 and pressing against it. On the end surface 9 there is a conical section 10 which from a midline 11 is transformed to an essentially spherical concentric form 12. The spherical part 12 of the adapter ends in a circular ring shaped surface 13 which is mainly parallel to the adapter head's opposite end surface 9. Further there is an adapter housing 14 which includes a tube shaped section 15 designed to be attached to the tube like structure, for which purpose the under part of which has a slit 16 (see for example Fig. 1) while the material on either side of the slit 16 has attachment members 17 for a connector 18, for example a bolt, with which the end of the tube shaped part, which is somewhat elastic because of the slit, can be fastened to the upper end of the tube like structure 2. On the end facing away from the slit part of the tube shaped section 15 of the adapter housing 14 the tube like structure meets a bowl shaped sleeve 19 concentric with the tube shaped section 15 and of a larger diameter than the latter. The sleeve 19 and the tube shaped section meet each other at a ring shaped connector 20 attached essentially perpendicular to the adapter housing's central axis. Through that connector extend a number, preferably four, equidistant angled threaded holes 21 designed for pinning screws 22 or the like. On the end of the collar 19 away from the tube shaped section 15 the collar has an encircling groove for a lock washer 24 with a hole 25 preferably of a form complementary to that of the spheroidal form 12 and with a contact line which, when assembled symmetrically, is in the middle of the spheroidal surface 12, that is, with its smaller opening turned axially out from the collar part when assembled, so that because of the increasing diameter of the spheroidal part 12 in the downward direction, after insertion into the sleeve 19 and attachment of the lock washer 24 the adapter head cannot be extracted from the sleeve but using the

pinning screws it can be locked at a desired angle. The lock washer 24 is preferably equipped with a slit (not shown) which facilitates its insertion into the groove 23.

The inner diameter of the opening in the sleeve 19 is somewhat larger than the outer diameter of the end surface 13 of the adapter head's spheroidal part 12 so that it fits into the sleeve and at its ring shaped end surface presses against the pinning screws 22 in the adapter housing 14, as for instance is seen in Fig. 1 where the adapter head's middle part 11 is above the sleeve 19. By inserting the lock washer 24 into the groove 23 in the adapter housing 14 after inserting the adapter head 8 into it the lock washer prevents the adapter head from being withdrawn from the sleeve 19 while at the same time because of the spheroidal part 12 the adapter head can be set at an angle relative to the lengthwise axis of the adapter housing. The angled hole 25 in the lock washer 24 thus also contributes to making that angular positioning smooth and frictionless without scratching contact between the spheroidal part 12 and the edge of the hole 25.

In Fig. 4 it is clear from the section of the adapter head 8 that approximately at the level of the external middle part 11 it has an interior partition which has a penetrating oval hole 27 placed symmetrically on the center of the interior partition 26, as is clear from Fig. 5 in which the adapter head is shown in a top view.

For internal connection between the prosthesis collar attachment member 4 and the adapter head 8 a connector 28 is used, in the example shown in the form of a bolt through the oval hole 27 in the adapter head with its threaded shaft screwed into the threaded hole 7 in the prosthesis collar attachment member 4. Because the connector 28 has a part that cannot go through the oval hole 27, that is, in the present case the head of the bolt is larger in diameter than the width of the hole 27, the connector can be applied without its head going through the hole 27. Because that hole is oval it is still possible to attach the connector 28 in different positions along the length of the hole making adjustment along the length of the hole possible. With the alternative design of the prosthesis collar attachment member with an oblong hole instead of the centered hole 7 using a slide groove (not shown) in the prosthesis collar attachment member it is possible to use a nut as the connector 28 which is self locking along the length of the hole in the prosthesis collar attachment member 4. Thus the extent of the adjustability of the prosthesis adapter is further increased.

In Fig. 6a-g the adapter 3 according to the invention is shown in section in different adjustment positions between the prosthesis collar attachment member 4 and the adapter head 8 and between the adapter head 8 and the adapter housing 14. In this way a great variety of adjustment positions is made possible which further can be realised with an adapter that can be of a low and particularly compact design because of the large spheroidal part of the adapter head in the sleeve of the adapter housing.

Thus Fig. 6a shows how the adapter head 8 is adjusted so that its center line forms a direct extension of the center line of the adapter housing 14, that is, no angular displacement of the center line results. On the other hand the axis of the

prosthesis collar attachment member 4 is shifted parallel with respect to the center line of the adapter head 8 and therefore to the center axis of the adapter housing. This has been achieved by shifting the connector 28 to its position, in the figure, furthest to the left in the oval hole 27 in the adapter head.

Also in Fig. 6b and 6c the adapter head 8 and the adapter housing are arranged with no angle between them while the prosthesis collar attachment member 4 in Fig. 6b is placed at its other maximally shifted end position and the connector 28 in Fig. 6c is placed centrally in the hole 27 so that the center line of the prosthesis collar attachment member 4 not only is parallel to but also coincides with the center line of the adapter housing 14 and of the adapter head 8.

In Fig. 6d and 6e is shown how the prosthesis collar attachment member 4 and the adapter head 8 are in the same relative position as shown in Fig. 6c but where in both cases the adapter head 8 has been rotated in its seat in the adapter housing 14 relative to the latter so that their respective center lines form an angle. This relative angular adjustment has been achieved in Fig. 6d by unscrewing the front pinning screw 22a almost completely from its hole 21 while the back screw has been screwed in to a corresponding extent. Thus the back screw 22b in the figure lifts the right part of the adapter head 8 which, because of the spheroidal external surface placed inside the sleeve part of the adapter housing, tips in the sleeve and rests at an angle to the left in the figure with its own center axis and the prosthesis collar attachment member center axis maximally angled to the left relative to the center axis of the adapter housing.

In Fig. 6e the situation is the reverse, that is, the front pinning screw 22a has been screwed in maximally while the back one 22b has been screwed out. The angle of the coincident center lines for the prosthesis collar attachment member 4 and the adapter head 8 relative to the center axis of the adapter head 8 is as great as is the case in Fig. 6d but in this case the center line of the prosthesis collar attachment member 4 and the adapter head 8 is angled to the right relative to the center line of the adapter housing.

In Fig. 6f and 6g are finally shown two positions in which the adapter housing 14 and the adapter head 8 are angled relative to each other in the same way as in figures 6d and 6e where the angular adjustment has been made in the same way as in the two previously described cases. In addition the center axes of the prosthesis collar attachment member 4 and the adapter head 8 in the two figures 6f and 6g are shifted parallel relative to each other in the same way and by the same means as in figures 6a and 6b, respectively.

For simplicity in figures 6d to 6g how the adapter head 8 and the adapter housing 14 have been angled relative to each other has been shown only in the plane of the paper where only the front and back pinning screws 22a and 22b, respectively, have been screwed into or out from their neutral positions. Because the adapter housing 14 can also have more equidistant adjustment screws 22, preferably four, it is assumed that the angular adjustment can also be achieved in a plane perpendicular to the plane of the paper and/or in a combination of the planes, that is, the angle between the adapter housing and the adapter head, and thereby

between the lower leg tube and the prosthesis collar attachment member 4, can be adjusted as desired to all angular positions while at the same time a sideways shift of the lower leg tube 2 and the prosthesis collar attachment member 4 can be obtained. Because the adapter head 8 has no fixed position relative to the adapter housing 14 the adapter head can also be rotated relative to the adapter housing 14 so that a parallel shift of the center axes of the prosthesis collar attachment member 4 and the adapter head 8 can be achieved in any desired direction perpendicular to the center axis of the adapter housing.

Using the design's large spheroidal adapter housing, which can be locked in position relative to the adapter housing in the way described and which has a built in sideways shift function, an extremely compact and therefore space saving design and a total adjustability for an externally applied knee/lower leg/foot prosthesis is achieved.

The invention is not limited to the shown and described exemplifications but instead modifications are possible within the frame of the following patent claims.

# Patent claims

1. Adjustable adapter (3) for a lower leg prosthesis including a tube shaped adapter housing (14) attachable to the lower leg prosthesis (2), a spheroidal adapter head (8) mounted rotatably therein and a prosthesis collar attachment member (4) that can be shifted sideways relative to the adapter head, which latter is attachable to a prosthesis collar (5),

characterized by

the adapter head's (8) spheroidal part (12) being formed on the outside of the essentially collar shaped adapter head (8) with an internal tube shaped part in which there are parts (26, 27 28) arranged to allow the prosthesis collar attachment member (4) to be shifted sideways.

2. Adapter according to patent claim 1,

characterized by

the collar shaped adapter head (8) being arranged so that in its assembled position its lower spheroidal part (12) can be locked axially in an upwardly open sleeve (19) attached to the adapter housing (14) whereby it is possible to angle the center axes of the adapter head (8) and the adapter housing (14) relative to each other.

3. Adapter according to patent claims 1 or 2,

characterized by

the lower part of the outside of the adapter head (8) having the said spheroidal part (12) with its spheroidal surface facing upward and which part meets a



midline (11) and then an essentially conically diverging part (10) which is terminated by a plane ring shaped surface (9) designed to abut against and be attached to the prosthesis collar attachment member (4).

4. Adapter according to any one of the previous claims,

characterized by

the adapter head (8) with its spheroidal part being attached to the sleeve (19) using a lock washer (24).

5. Adapter according to any one of the previous claims,

characterized by

the adapter head (8) and the prosthesis collar attachment member (4) being joined by a connector (28) extending internally from the adapter head.

6. Adapter according to patent claim 5

characterized by

the adapter head (8) in its penetrating axial hole having a transverse internal partition (26) with a groove (27) arranged therein through which the said connector (28) is arranged to extend.

7. Adapter according to any one of the previous claims,

characterized by

the adapter housing (14) having an outward facing flange (20) at the transition between its tube shaped part (15) attachable to a lower leg prosthesis (2) and its sleeve (19), through which flange (20) from the outside of the tube shaped section (15) to the inside of the sleeve (19) there extending an adjustment member (22, 22a, 22b) which in a known way is arranged to adjust the angle of the adapter head (8) relative to the adapter housing (14).

**AMENDED CLAIMS**

[received by the International Bureau on 7 April 1997 (07.04.97);  
original claims 1-7 replaced by amended claims 1-5 (3 pages)]

1. Adjustable adapter (3) especially for a lower leg prosthesis (2), including an adapter housing (14) attachable to the lower leg prosthesis (2), a part-spheroidal adapter head (8) moveably mounted therein and adjustable by means of adjustment means (22) for the adapter housing, and a prosthesis collar attachment member (4) which is sideways displaceable relative to the adapter head, said prosthesis collar attachment member is connected to a prosthesis collar (5) and to the adapter housing (14),

c h a r a c t e r i z e d i n

that the part-spheroidal portion (12) of the adapter head (8) in mounted position is integrated with the adapter housing (14) forming one of two parts of a unit, said parts are moveable relative to each other and settable in different positions by means of the adjustment means (22) independant of the adjustability and attachment of the adapter housing to the prosthesis collar attachment member (4),

that in the adapter head (8) there is arranged an elongated through groove (27), through which said locking member (28) extends and which permit a transversal movement between the adapter head (8) and the prosthesis collar attachment (4) independant of the adjustability relative to the adapter head (8).

2. Adapter according to claim 1,

c h a r a c t e r i z e d i n

that the part-spheroidal portion (12) of the adapter head (8) is designed to pass into a waist protion (11) and then into a substantially conically widening portion (10), which terminates with a plane end surface (9) intended to contact the prosthesis

**AMENDED SHEET (ARTICLE 19)**

collar attachment member (4).

3. Adapter according to claim 1,  
c h a r a c t e r i z e d i n  
that the part-spheroidal portion (12) of the adapter head (8) is  
fixed in the adapter housing by means of a preferably openable  
lock washer (24).

4. Adapter according to claim 1,  
c h a r a c t e r i z e d i n  
that one end surface (9) of the adapter housing (8) and a ring-  
shaped end surface (13) of the part-spheroidal portion (12) are  
substantially parallel, and that the adjustment means (22) of the  
adapter housing (8) is arranged to act upon said ring-shaped end  
surface (13) of the part-spheroidal portion (12).

5. Method of mounting an adjustable adapter (3) for lower leg  
prosthesis (2) including an adapter housing (14) and a part-  
spheroidal adapter head (8) rotatably mounted therein and which  
by means of adjustment means (22) in the adapter housing is  
adjustable with respect to this,  
c h a r a c t e r i z e d i n  
that the part-spheroidal portion (12) of the adapter head (8) is  
inserted in a socket-provided (19) part of the adapter housing,  
that an openable lock washer (24) is placed about a waist (11)  
between the part-spheroidal portion of the adapter head and a  
conically widening connection portion (10) connected therewith,  
that the adapter head (8) is inserted into the socket (19) so far  
that the waist will be located just opposite a ring groove (23)  
in the socket,  
that the lock washer (24) is snapped into the ring groove (23),

and that the adjustment means (22) is tightened to such an extent that the part-spheroidal portion is pressed in contact against the lock washer.

AMENDED SHEET (ARTICLE 19)

FIG. 1

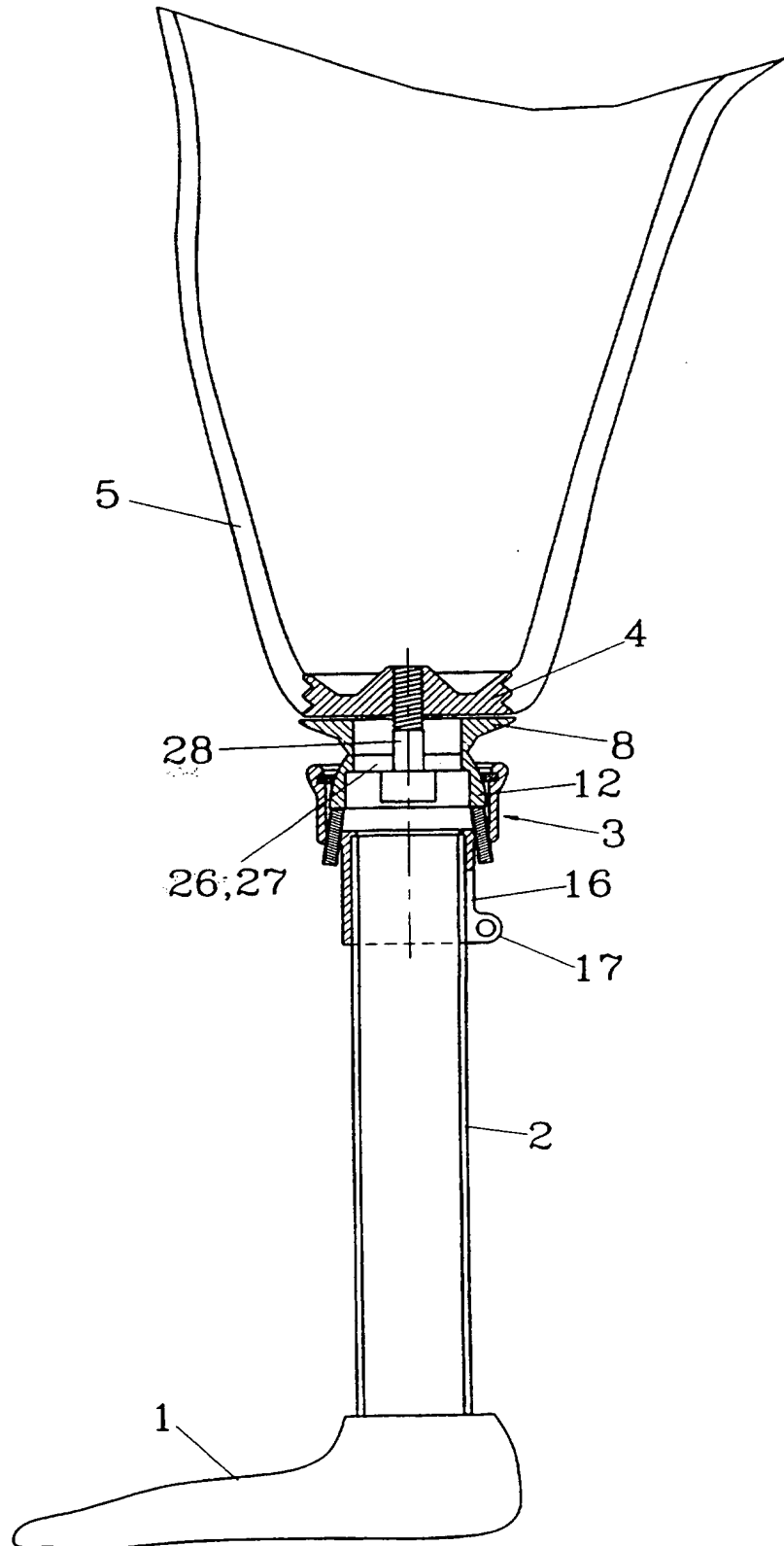
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FIG. 2

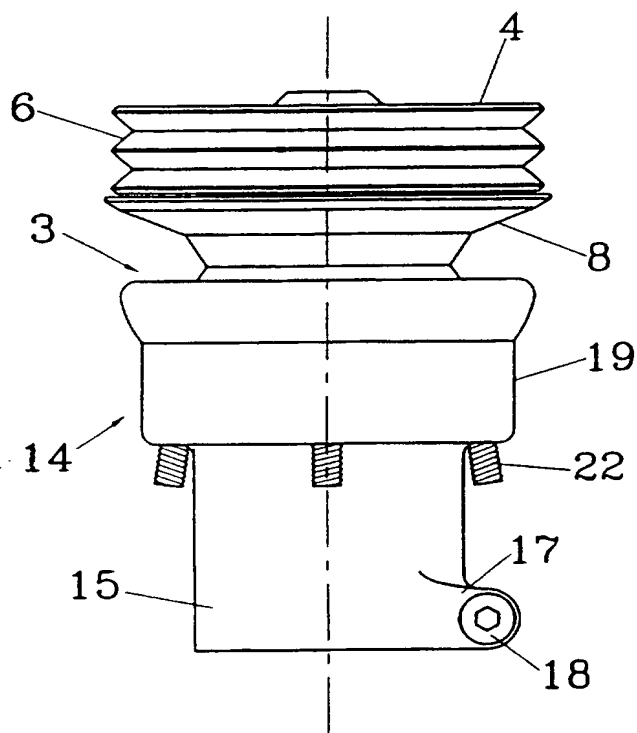


FIG. 3

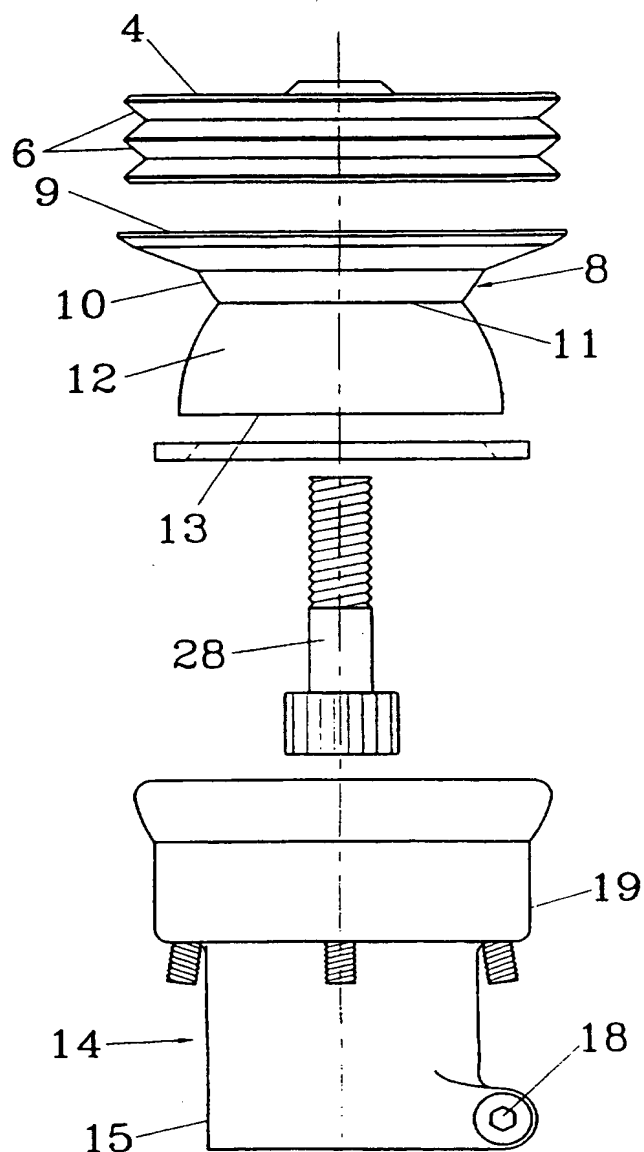


FIG.4

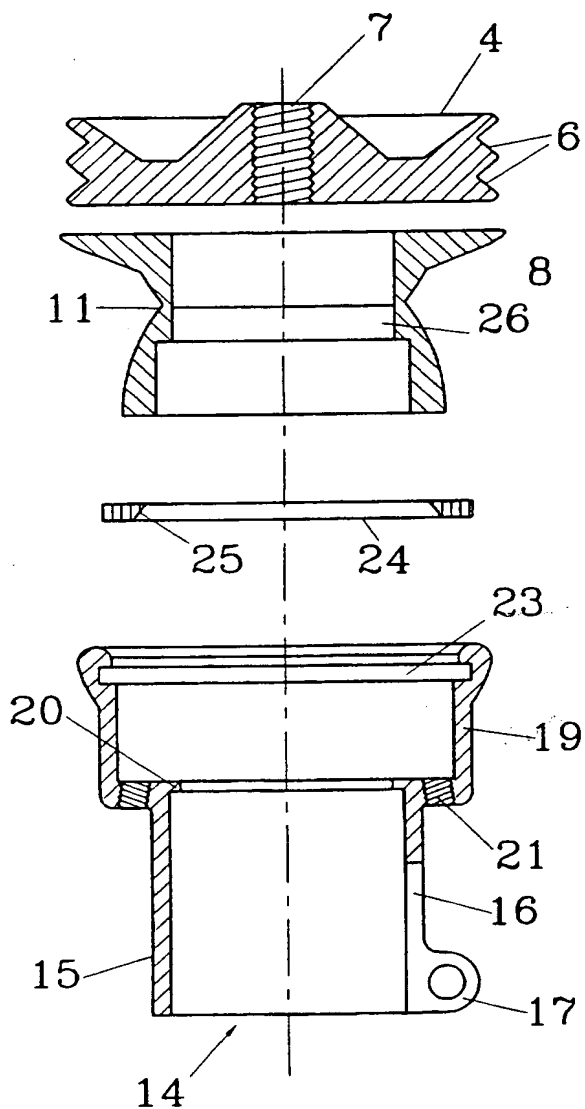


FIG.5

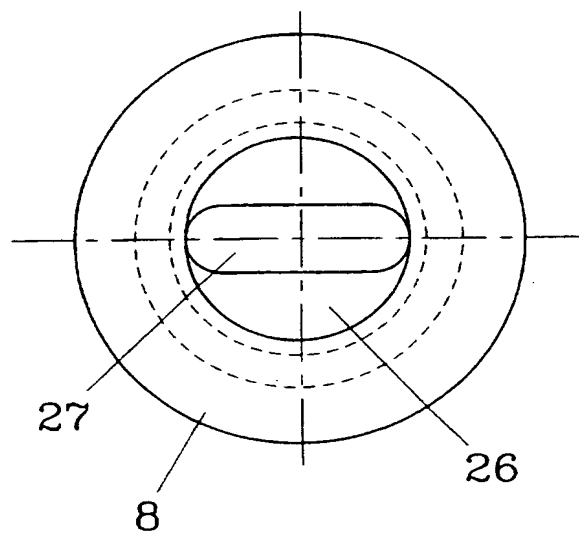


FIG. 6c

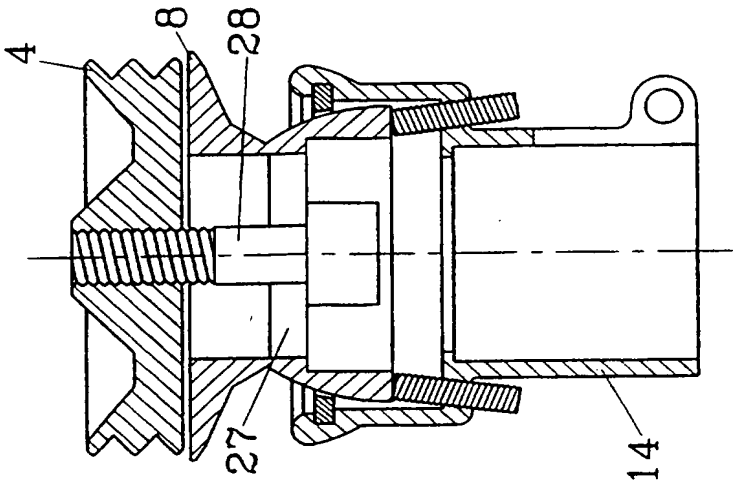


FIG. 6b

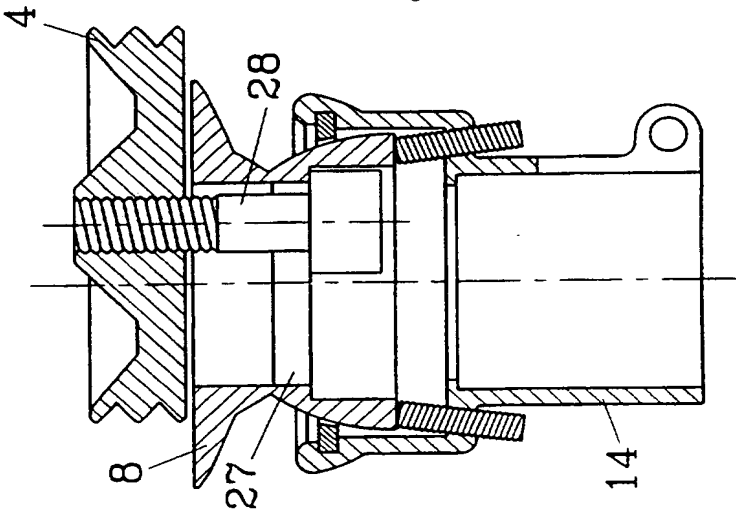


FIG. 6a

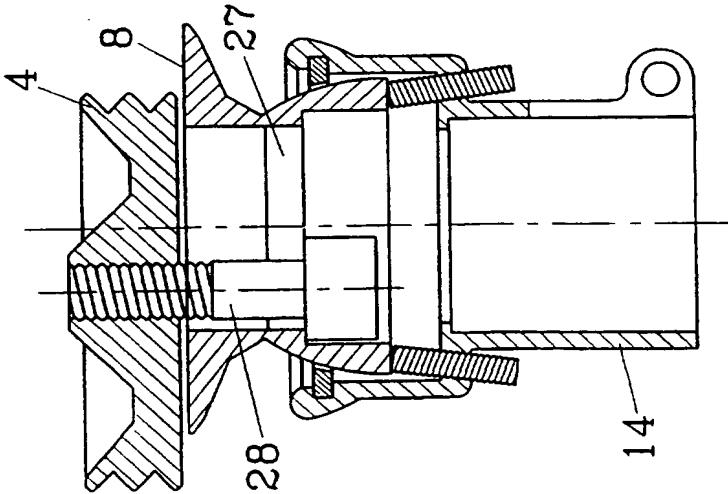




FIG. 6e

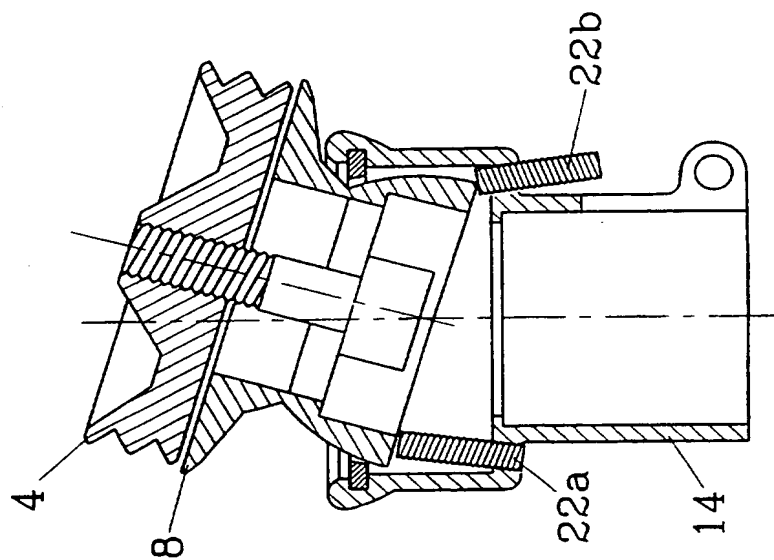


FIG. 6d

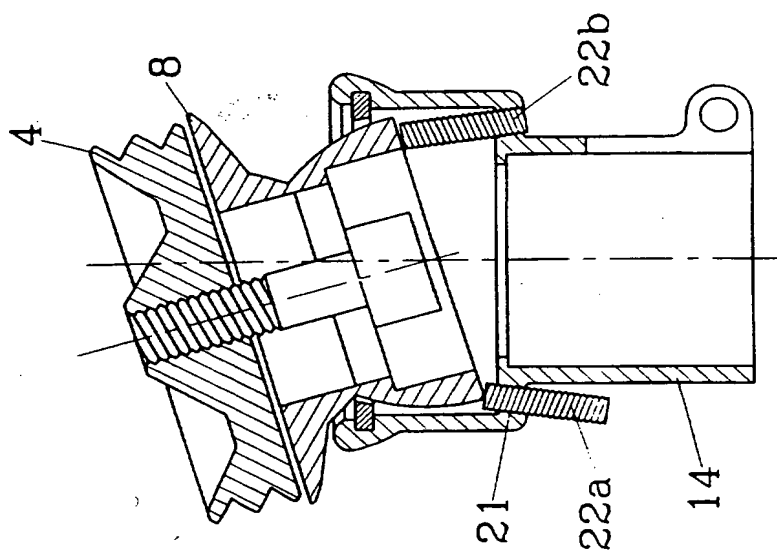


FIG. 6g

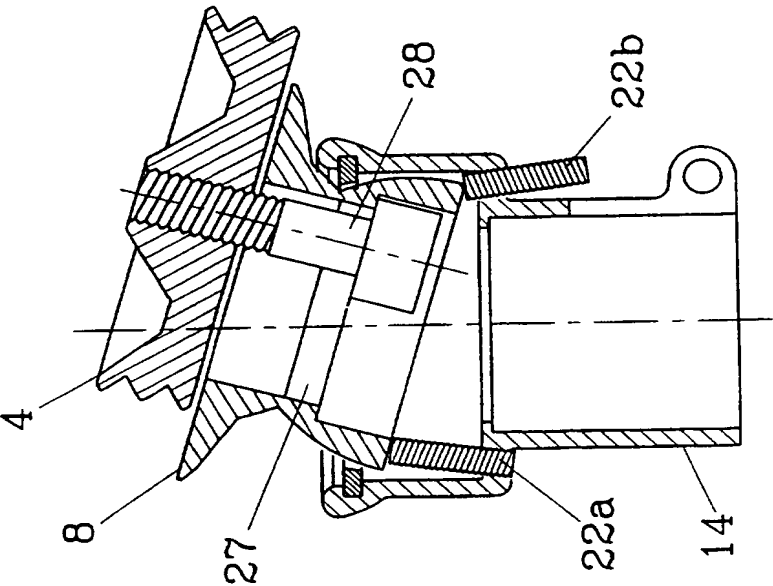
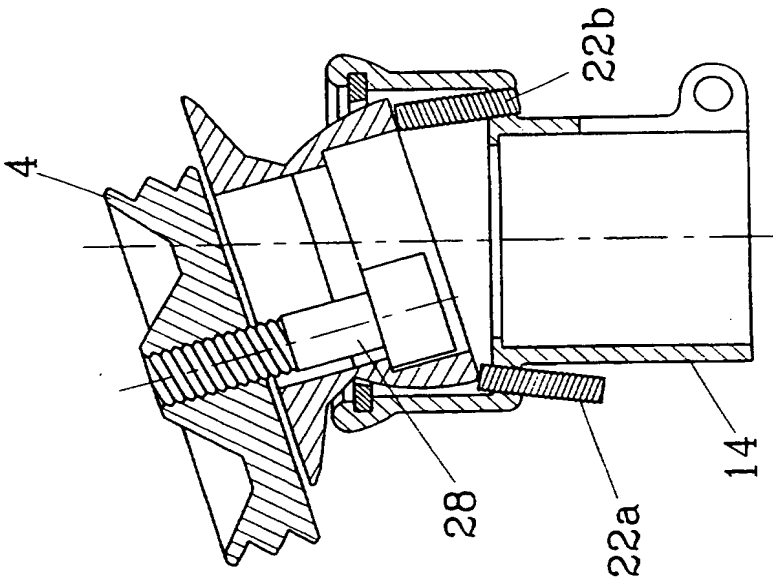


FIG. 6f



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 96/01422

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A61F 2/62

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category <sup>o</sup>	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9317640 A1 (PHILLIPS, VAN, L.), 16 Sept 1993 (16.09.93), page 6, line 5 - line 31, figure 2 --	1-7
A	US 5458657 A (JAMES K. RASMUSSEN), 17 October 1995 (17.10.95), column 8, line 57 - column 9, line 20 -----	1-7

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.<sup>o</sup> Special categories of cited documents:<sup>"A"</sup> document defining the general state of the art which is not considered to be of particular relevance<sup>"E"</sup> earlier document but published on or after the international filing date<sup>"L"</sup> document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)<sup>"O"</sup> document referring to an oral disclosure, use, exhibition or other means<sup>"P"</sup> document published prior to the international filing date but later than the priority date claimed<sup>"T"</sup> later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention<sup>"X"</sup> document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone<sup>"Y"</sup> document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art<sup>"&"</sup> document member of the same patent family

Date of the actual completion of the international search

11 February 1997

Date of mailing of the international search report

25 -02- 1997

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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

28/10/96

International application No.  
PCT/SE 96/01422

Patent document cited in search report	Publication date	Patent family member(s)	- Publication date
WO-A1- 9317640	16/09/93	US-A- 5425782	20/06/95
US-A- 5458657	17/10/95	NONE	

Form PCT/ISA/210 (patent family annex) (July 1992)